

Docket No.: ABK-001.02

KNOWLEDGE ACQUISITION AND RETRIEVAL APPARATUS AND METHOD

CLAIM OF PRIORITY

**[0001]** This application is a continuation application of U.S.S.N. 09/541,247, filed April 3, 2000 entitled "Knowledge Acquisition and Retrieval Apparatus and Method," and now U.S. Patent 6,611,841, where U.S. Patent 6,611,841 claims priority to U.S.S.N. 60/127,764, filed April 2, 1999, entitled "Two Stage Artificial Memory Processes," the contents of all of which are incorporated herein by reference in their entirety.

BACKGROUND

(1) Field of the Invention

**[0002]** The present invention relates generally to information storage and retrieval, and more particularly to knowledge-based information storage and retrieval.

(2) Description of the Prior Art

**[0003]** A computer does not store, process, or retrieve information in the same manner as the human brain. In nearly all instances, the human knowledge processing system is more efficient than existing computer processing algorithms. Research and concepts including neural networks, fuzzy logic, etc., attempt to simulate the human brain's vast capability to learn and associate in complex manners. U.S. Patent 5,761,496 to Hattori presents an information retrieval system that retrieves information on a trial and error basis based upon a keyword input by the user and previously stored background information. Alternately, U.S. Patent 6,026,393 to Gupta et al. presents a system and method to reduce the cases applicable to a current problem in a case-based reasoning system. U.S. Patent 6,038,560 to Wical discloses a concept knowledge base search

1 and retrieval system wherein document theme vectors allow a query system to produce  
2 terminology that identifies the potential existence of documents for the queried subject matter.  
3 Such existing systems are useful for retrieving a particular class or category of data, where the  
4 data is of one particular species. These systems implement rule-based solutions as opposed to  
5 structure-based solutions that are constructed in the human brain. This is a severe limitation for  
6 continued progress in robotics and artificial intelligence.

7 **[0004]** The human brain's associative capabilities are not limited like a computer to words or  
8 pure binary data stimuli. The human brain makes associations based upon visual data, auditory  
9 data, sensory data such as touch, and motion data, all of which emanate from the physical world.  
10 The human brain therefore stores, associates, and can recall multiple data species with a single  
11 object. For example, the brain may associate "banana" with the category of fruit, the spoken  
12 word banana, the image of a ripe yellow banana, the image of a non-ripe green banana, the smell  
13 of a banana, the texture of a banana peel, etc.

14 **[0005]** There is not currently a knowledge acquisition and retrieval apparatus or method that  
15 provides human-like storage, relationship, and retrieval for a multitude of data classes and  
16 species. What is needed is an apparatus and method that simulates the human brain's capacity to  
17 learn, relate, and recall relationships and associations for a multitude of different categories and  
18 data species.

## SUMMARY

[0006] The present invention provides an apparatus and method to organize, transform, and associate information between two conceptually graduated memory stages. For the acquisition stage, the invention provides an input system allowing presentation of multiple format data to the memory. As data is acquired, the memory stages build and maintain reciprocal associations. Such reciprocal associations allow cooperative processing between the memory stages to form a hierarchical association between related elements. This hierarchical association is exploited during the data retrieval process. Data retrieval may occur using as many as seven different retrieval algorithms that emulate the human cognitive functions.

[0007] Other objects and advantages of the present invention will become more obvious hereinafter in the specification and drawings.

[0008] These objects are accomplished with the present invention by a knowledge acquisition and retrieval apparatus and method that emulate the human brain and comprise at least one first memory segment, and a distinct second memory segment, wherein elements of the at least one first memory segment are reciprocally associated to elements of the second memory segment, and vice-versa. The at least one first memory segment comprises categorized data from the physical world, known as representational data, while the second memory segment contains abstract or conceptual data, otherwise known as consciousness data. Physical data comprises auditory data, language data, visual data, motion data, and sensory data, and each element of the at least one first memory segment is identified as auditory data, language data, visual data, motion data, or sensory data. By reciprocally associating the physical (representational) and conceptual

(consciousness) data, a hierarchical structure is created that allows information retrieval by traversing the reciprocal associations. Varying retrieval algorithms traverse the hierarchical structure differently to generate specified system outputs. Retrieval algorithms are implemented to represent human information retrieval functions commonly known as reduction, imaging, deduction, recognition, recall, categorization, and reasoning.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0009]** A more complete understanding of the invention and many of the attendant advantages thereto will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts and wherein:

**[0010]** FIG. 1 diagrammatically presents the basic structural knowledge acquisition and retrieval system;

**[0011]** FIG. 2 presents an example of the reciprocal association algorithm;

**[0012]** FIG. 3 is a sample, reciprocally associated database containing a physical data segment and a conceptual data segment;

**[0013]** FIG. 4 diagrammatically presents a hierarchical structure as viewed by retrieval algorithms;

**[0014]** FIG. 5 displays the retrieval algorithms of the preferred embodiment, and their mathematical representations as described herein;

**[0015]** FIG. 6 depicts the external systems and functionality that may be imported or exported from the knowledge acquisition and retrieval system; and,



1 systems and methods described herein have wide applicability and can be incorporated in many  
2 systems, and realized in many forms, all without departing from the scope of the invention.

3 **[0019]** Referring to FIG. 1, the knowledge acquisition and retrieval system 10 shall be described  
4 by referring to four basic structural components that are presented merely for explanatory  
5 purposes, and are not intended to represent a limitation of the invention herein: An  
6 input/acquisition module 12, a storage/association module 14, a retrieval module 16, and an  
7 output module 17. Because the storage/association module 14 dictates the input/acquisition  
8 module 12 and retrieval module 16 components, the storage/association module 14 shall be  
9 described first.

10 **[0020]** As shown by FIG. 1, the storage/association module 14 is comprised of an association  
11 algorithm 18, and two memory segments designated the physical memory segment 20, and the  
12 conceptual memory segment 22. The association algorithm interfaces between the  
13 input/acquisition module 12 and the two memory segments 20, 22 to ensure that all outputs of  
14 the input/acquisition module 12 resolve into reciprocally associated physical and conceptual  
15 memory elements.

16 **[0021]** The storage/association module 14 contains two memory segments 20, 22 to emulate the  
17 human brain storage mechanism. The human brain contains two memories that shall be referred  
18 to herein as representational memory and consciousness memory. Representational information  
19 is information received directly by the senses from the physical world. Alternately,  
20 consciousness information is not received directly from the senses, but is rather generated from  
21 representational information and may be viewed as a property of representational information or

1 a shared group of representational information. Consciousness data is abstract data, and is  
2 retained at a higher level of categorization than the representational data received from the  
3 physical world. For simplicity, the remainder of this specification shall refer to representational  
4 data as physical data, and consciousness data as conceptual data. Correspondingly, FIG. 1  
5 indicates the physical memory segment 20 for storing physical data, and the conceptual memory  
6 segment 22 for storing conceptual data.

7 **[0022]** The association algorithm 18 ensures that each physical memory element is reciprocally  
8 associated to at least one conceptual memory element. Because the physical and conceptual  
9 memory segments 20, 22 are reciprocally associated, they may be constructed from a single  
10 memory that is divided into two segments, or two physically separate memory segments.  
11 Similarly the reciprocal associations can be established through any linking device including  
12 pointers and/or linked lists, but the invention is not so limited. In the preferred embodiment, the  
13 memory is constructed upon a database system, such as Microsoft Access, ODBC, or SQL  
14 Server.

15 **[0023]** In the preferred embodiment, the input/acquisition module 12 is a multi-modality input  
16 system that simulates the human senses. Referring to FIG. 1, the input/acquisition module 12  
17 contains interfaces to accept auditory data 24 including sounds input by a microphone, visual  
18 data 26 including graphs and images, language data 28 including written, spoken, scanned, and  
19 FAXed text, motion data 30 including positional information from sonar, radar, etc., and sensor  
20 data 32 that may be from any electronic measuring device including sonar, radar, temperature  
21 sensors, medical devices, etc.

1       **[0024]** Each of the multi-modal input interfaces requires the user to identify that data comprising  
2       the physical data, and that data comprising the conceptual data. For example, auditory  
3       information may be input through a microphone to record a baby crying. The sound is the  
4       physical data, while “baby crying” is the abstract or conceptual data. A picture of Abraham  
5       Lincoln may be scanned through the visual data interface as physical data, with “Abraham  
6       Lincoln” associated as the conceptual data. Language data may be input through any interface,  
7       for example a graphical user interface (GUI) that prompts for physical and conceptual data pairs,  
8       e.g., “George Washington”–“president” may be entered as the physical–conceptual pair.  
9       Positional data received from radar is representative of physical data from the motion data  
10      interface 30, while the corresponding conceptual data would be “current position”. Similarly, a  
11      temperature reading from a thermometer may be introduced through the sensor data interface 32  
12      as physical data, with the associated conceptual data being “temperature”.

13      **[0025]** The association algorithm 18 within the storage/association module 14 is responsible for  
14      accepting the physical-conceptual data pairings from the multi-modal input/acquisition module  
15      12, transferring the data to the respective physical and conceptual memory segments, 20, 22, and  
16      ensuring reciprocal associations between the newly entered data elements. A further function of  
17      the association algorithm 18 is to ensure that the physical data is properly identified as auditory,  
18      visual, language, motion, or sensory.

19      **[0026]** In the preferred embodiment, to further emulate the human brain, the physical data  
20      memory segment 20 is further divided into multiple partitions, with each partition corresponding  
21      to a respective input mode or data type. As shown by FIG. 1, because there are five different



1 modal inputs (e.g., auditory, visual, language, motion, and sensor), the physical memory segment  
2 20 maintains five partitions, thereby organizing the information received by each modal input.  
3 Alternately, conceptual memory 22 is not partitioned.

4 **[0027]** Referring now to FIG. 2A, there is shown an example of the physical and conceptual  
5 memory segments after language data is input through the language data interface. In the  
6 preferred embodiment, the language data interface comprises a GUI that prompts a user for  
7 physical data and its associated conceptual data. In the example provided, “George Washington–  
8 President” is entered as the physical-conceptual data pair. From this data pair, the system  
9 “learns” the relationship between the physical and conceptual elements by associating the  
10 physical and conceptual data elements as shown by FIG. 2A. For simplicity, FIG. 2A represents  
11 only the language partition of the physical data memory 20.

12 **[0028]** Upon receiving the data pair “George Washington–President”, the association algorithm  
13 18 seeks to establish three reciprocal associations between the physical and conceptual memory  
14 segments. In this instance, the language partition of the physical data segment is utilized because  
15 the data is from the language data interface. The first association is established using the rule  
16 that every physical data element is reciprocally associated to a conceptual data element. In FIG.  
17 2A, “George Washington” is reciprocally associated 50 to the abstract concept “G”. The second  
18 reciprocal association is established by the rule that every conceptual data element is reciprocally  
19 associated to a physical data element. In FIG. 2A, this reciprocal association is demonstrated by  
20 “president” (physical data) reciprocally associating 52 to the abstract concept “P”. The third  
21 reciprocal association is established by the data pairing itself, and shown in FIG. 2A as 54. The

1 physical (language partition) data of “George Washington” is reciprocally associated 54 to the  
2 abstract concept of “P”, wherein P is shown by 52 to be the abstract concept relating to the  
3 physical data of president. The three reciprocal connections 50, 52, 54 complete the learning  
4 process for the example input.

5 **[0029]** Continuing the example, consider that additional language information is input similarly  
6 as “Abraham Lincoln-President”. Referring now to FIG. 2B, there is shown the physical and  
7 conceptual memory segments 20, 22 with pre-existing reciprocal associations from FIG. 2A, and  
8 new reciprocal associations indicated. The association algorithm first establishes a reciprocal  
9 association 56 between “Abraham Lincoln” in the physical memory segment (language partition)  
10 and an abstract concept A in conceptual memory 20. Secondly, the association algorithm seeks  
11 to establish an association between the conceptual element P and president; however, this  
12 relationship has already been learned, and therefore it is not necessary to “learn” this concept  
13 again by entering the relationship. Thirdly, a reciprocal association is established between the  
14 physical data of “Abraham Lincoln” and the conceptual data P 58, wherein P is the conceptual  
15 element relating to the physical data known as “President”.

16 **[0030]** As a third step in the input/acquisition process, consider a visual input comprising an  
17 image of Abraham Lincoln. The physical data is the image, while the conceptual data is  
18 “Abraham Lincoln.” Referring now to FIG. 2C, there is shown pre-existing reciprocal  
19 associations from FIG. 2B, with additional reciprocal associations established. The association  
20 algorithm will place the image in the visual data partition of physical memory 20, and establish  
21 the reciprocal associations. First, a reciprocal association 60 is established between the physical

1 data image and a conceptual data element. Secondly, a reciprocal association between the  
2 concept “Abraham Lincoln” and a physical data element is sought, and determined to be already  
3 established, or learned. Thirdly, the physical data image is reciprocally associated to the abstract  
4 concept representing Abraham Lincoln 62.

5 **[0031]** Although the example provided was limited to language and visual data, as already noted,  
6 the invention is not so limited, additionally allowing auditory, motion, and sensor data, with  
7 similar partitions of the physical memory segment. Similarly, although the invention is capable  
8 of auditory, motion, visual, sensor, and language inputs, it is not necessary to include all input  
9 modes to embody the invention. The number of associations created is only limited by the  
10 memory segment size (if physical data is partitioned into segments, partition sizes must also be  
11 considered.)

12 **[0032]** Referring back to FIG. 1, the third major component of the knowledge acquisition and  
13 retrieval system 10 is the retrieval module 16. The retrieval module 16 is primarily responsible  
14 for emulating the human brain’s cognitive capabilities by retrieving data from physical memory  
15 and outputting the data to a desired format or medium for the multi-modal output module 17.  
16 Because the physical data is divided into auditory, visual, language, motion, and sensor  
17 partitions, with each partition representative of the data stored therein, the potential system  
18 outputs are correspondingly auditory, visual, language, motion, and sensor data. Auditory data  
19 may be output to a speaker, visual and language data may be output to document, screen, GUI, or  
20 other computer readable medium, and motion and sensor data may be output to another device,

instrument, GUI, document, etc. The output module 17, similar to the input/acquisition module 12, is also multi-modal, and comprises interfaces to the various output devices.

**[0033]** The retrieval module 16 comprises a set of algorithms that traverse reciprocal associations between the physical memory segment 20 and the conceptual memory segment 22 according to a designated retrieval method. Because the knowledge acquisition and retrieval system 10 emulates the human brain, all outputs must be extracted from physical memory 20, whose elements represent the physical world. In the retrieval process, conceptual memory 22 is accessed merely to derive associations to physical memory elements.

**[0034]** In the preferred embodiment, the retrieval module 16 comprises seven retrieval algorithms that are selectable through a GUI. Depending upon the selected retrieval algorithm, the GUI prompts the user for inputs. The seven retrieval algorithms simulate human brain retrieval processes, and are defined as deduction 34, reduction 36, recall 38, recognition 40, imaging 42, categorization 44, and reasoning 46.

**[0035]** Deduction 34 is a retrieval algorithm to extract exclusively from the language partition of physical data memory. Deduction is defined as the set of conceptual data related to a physical data element, wherein the physical data element is categorized as language data, and the related conceptual data is associated to language data. Referring now to FIG. 3, there is shown a database representing the language partition of physical data memory 20, and conceptual data memory 22, with established reciprocal associations as indicated. A deduction retrieval request for the user-specified physical data element “George Washington” presents the set of conceptual data associated to “George Washington”. Using the example database of FIG. 3, a search

1 through physical data memory for all conceptual data associated to “George Washington”  
2 provides conceptual data “G” and “P”. Once again, the retrieval algorithm cannot generate  
3 abstract ideas, but must generate the corresponding physical world equivalents. Since “G”  
4 reciprocates to “George Washington”, or the input data, it is not provided as an output; however,  
5 “P” reciprocates to “President”, which comprises physical world data different from the input.  
6 The deductive output for “George Washington” is therefore “President”. This process is  
7 considered a linear retrieval from conceptual data (consciousness data), wherein the input is  
8 physical, language data, and the output is also language data associated with the retrieved  
9 conceptual data. Because there is only one input yet potential multiple outputs, this process is  
10 hereby defined as a single-input process. This retrieval may be mathematically expressed as  
11  $L < C$ , where L signifies the input Language data, < indicates a single input producing potentially  
12 multiple outputs, and C signifies the retrieved conceptual data.

13 **[0036]** Recognition retrieval 40 is the same retrieval algorithm as deduction, except whereas  
14 deduction is limited to a single, language physical data input, recognition retrieval 40 accepts as  
15 input a single, physical data input from any physical data category other than the language type  
16 (i.e., auditory, visual, motion, or sensor), and outputs the conceptual data related to the input.  
17 Depending upon the input category, this retrieval may be mathematically expressed as  $A < C$ ,  
18  $V < C$ ,  $M < C$ ,  $S < C$ , where A signifies auditory data input, V signifies visual data input, M signifies  
19 motion data input, and S signifies sensor data input. Once again, as in deduction, there are  
20 potential multiple outputs for recognition.

1       **[0037]** Reduction retrieval 36, like deduction retrieval 34, is limited to retrieving physical data  
2       from the language partition. Reduction retrieval generates the set of (language) physical data that  
3       is related to a specified conceptual idea (input). Referring again to the sample database of FIG.  
4       3, if “Leader” is presented as the conceptual element, “Leader” is conceptually represented as  
5       “L”. A search through conceptual memory for all physical data associated to “L” (other than the  
6       input, “Leader”) provides “President”, “Monarch”, and “Dictator”, which comprise the output of  
7       a reduction inquiry with “Leader” as the input. In reduction, there is exactly one input, yet  
8       potential multiple outputs. Mathematically, this may be represented as  $C < L$ , where C signifies  
9       the single conceptual data input, < signifies a single input and potential multiple outputs, and L  
10      signifies the Language data output(s).

11      **[0038]** Recall retrieval 38 is an algorithm performing the same procedure as reduction, except  
12      recall requires two or more conceptual data inputs. Recall provides as output those physical data  
13      elements identified as language data, that represent the physical data common to the two or more  
14      conceptual data inputs. Referring to the sample database of FIG. 3, consider two inputs of  
15      “Leader” and “Monarch” as the conceptual elements, corresponding to “L” and “M” respectively.  
16      Referring now to FIG. 4A, there is shown the tree diagram representing the recall retrieval  
17      algorithm. A search through conceptual data for “L” provides reciprocal associations with  
18      “President”, “Monarch”, and “Dictator”, otherwise conceptually represented as “P”, “M”, and  
19      “D”, respectively. Because the connection containing “L” and “M” is the desired connection and  
20      it is already established, it is now only necessary to pursue the reciprocal associations of the  
21      common branch 70. A search through the FIG. 3 database conceptual data for the conceptual

data “M” provides a single reciprocal association to “Queen Elizabeth”. A similar search in  
 conceptual data for “Q”, the conceptual equivalent of “Queen Elizabeth”, does not provide any  
 reciprocal associations, thereby ending the recall retrieval algorithm. The single recall algorithm  
 output for this example is therefore “Queen Elizabeth”; however, if multiple monarchs were  
 listed, the recall retrieval would have produced multiple outputs. This recall function operates in  
 the same manner as the human brain to recall information having specified common properties.  
 Mathematically, recall retrieval may be expressed as  $C > L$ , where C signifies conceptual data, >  
 indicates multiple inputs with potential multiple outputs, and L signifies language, physical data.  
 An alternate mathematical representation for recall with two inputs may be  $C_1 + C_2 > L_1 \wedge L_2$ ,  
 where  $C_1$  is the first conceptual input,  $C_2$  is the second conceptual input,  $L_1$  is the language  
 physical data associated with  $C_1$ ,  $L_2$  is the language physical data associated with  $C_2$ , and  $\wedge$   
 denotes intersection.

**[0039]** Imaging retrieval 42 is the same retrieval process as recall retrieval 36, however whereas  
 recall 36 is limited to retrieving from the language partition of the physical memory segment,  
 imaging 42 is limited to retrieving from the auditory, visual, motion, and sensor partitions of  
 physical memory 20. Imaging may be mathematically represented as  $C > A$ ,  $C > V$ ,  $C > M$ , and  
 $C > S$ , where C signifies the multiple conceptual data inputs, > represents multiple inputs, and A  
 signifies potential multiple auditory outputs, V signifies potential multiple visual outputs, M  
 signifies potential multiple motion outputs, and S signifies potential multiple sensor outputs.  
 Alternately, imaging for two inputs may be represented as  $C_1 + C_2 > R_1 \wedge R_2$ , where  $C_1$  and  $C_2$

are the conceptual inputs,  $R_1$  and  $R_2$  are the respective, non-language representational (physical) data, and  $\wedge$  denotes intersection.

**[0040]** Categorization retrieval 44 requires two or more inputs representing physical data inputs.

Categorization retrieval produces those conceptual data elements that the two physical data inputs share. As an example using the database from FIG. 3, consider inputs of “Queen Elizabeth” and “George Washington”. Conceptually, categorization produces a tree for each physical data input, and produces as output the common elements, or intersection, of the respective trees. FIG. 4B illustrates the trees produced for the respective physical data inputs. Using the FIG. 3 sample database, a search for “Queen Elizabeth” in physical data presents reciprocal associations to M conceptually. M is physically represented as Monarch, and a search for “Monarch” in physical data produces reciprocal associations to conceptual data L. Continuing, a search of physical data for “Leader” (corresponding to L) provides reciprocal associations with H, or “Human Being”. A search of “Human Being” in physical data does not reciprocally associate with any other concept, thereby ending the tree 80. A similarly constructed tree may be produced by performing the same analysis using the FIG. 3 sample database, but beginning with “George Washington” 82, and repeatedly searching the physical data memory for reciprocal associations. The categorization output is the intersection of the trees for “Queen Elizabeth” 80 and “George Washington” 82, thereby producing an output of “Leader” and “Human Being”. Much like the human mind, categorization retrieval generates the common elements, i.e., Queen Elizabeth and George Washington both were leaders and human beings. Mathematically, categorization may be represented as  $R > C$ , where R signifies representational



1 data (i.e., any physical data),  $>$  represents multiple inputs and potential multiple outputs, and  $C$   
2 signifies the potential, multiple conceptual data outputs. An alternate mathematical  
3 representation for two inputs is  $R1 + R2 > C1 \wedge C2$ , where  $R1$  and  $R2$  are the physical  
4 (representational) data inputs,  $C1$  and  $C2$  are the corresponding conceptual data, and  $\wedge$  denotes  
5 intersection.

6 **[0041]** Referring back to FIG. 1, reasoning retrieval 46 accepts two or more elements from  
7 physical data as input, and generates an output equivalent to those conceptual data elements that  
8 connect the reasoning inputs through deduction. For example, referring to the sample FIG. 3  
9 database, consider as input “George Washington” and “Leader”. “George Washington” connects  
10 conceptually to “P”, or “President”, and “President” connects to “L”, or “Leader”. The reasoning  
11 retrieval output for the present example is therefore “President” as the conceptual (“P”)  
12 connection between the two terms. Again, the human mind, when presented with “George  
13 Washington” and “Leader”, would reason that George Washington was a leader because he was a  
14 President. Mathematically, reasoning may be represented as  $R1 \text{ --- } R2 < C1 \wedge Cn \wedge C2$ , where  
15  $R1$  and  $R2$  are the physical (representational) data input pair,  $C1$  and  $C2$  are the respective  
16 conceptual data elements,  $Cn$  represents all conceptual data elements connecting  $C1$  and  $C2$ , and  
17  $\wedge$  denotes intersection.

18 **[0042]** Referring now to FIG. 5, there is shown a summary of the seven retrieval algorithms with  
19 their corresponding mathematical representations as provided herein.

20 **[0043]** Referring now to FIG. 6, there is shown the knowledge acquisition and retrieval system  
21 10 to illustrate additional capabilities regarding interaction with other systems. Although the

1 present invention provides multi-modality input and output systems for auditory, language,  
2 visual, motion, and sensor data, the system 10 also allows mechanisms for data export, data  
3 import, and data adoption.

4 **[0044]** Data export is a function whereby the physical and conceptual memories, and the  
5 reciprocal associations established therein, are written in a formatted manner to an external  
6 device 92. Such external device may be a data file, other computer system connected through a  
7 network, or any computer readable medium. These formatted data associations 92 may then be  
8 imported by another system practicing the invention presented herein. The import of the  
9 formatted database 94 does not require any conversion as the formatted database comprises the  
10 required reciprocal associations. Data import from a formatted database is a direct operation  
11 from the external database, to the physical and conceptual memory segments.

12 **[0045]** Alternately, generic databases 96 may provide data for input to the reciprocally associated  
13 physical and conceptual memories; however, because traditional databases do not provide the  
14 reciprocal associations required by the invention herein, the generic data must be reformatted to  
15 provide reciprocal association for entry into the physical and conceptual memory segments. This  
16 process is known as adoption. In the preferred embodiment, the knowledge acquisition and  
17 retrieval system 10 provides a GUI that allows selection of specific, generic databases that may  
18 be adapted to the reciprocal memory. Examples of such specific databases that can be adopted  
19 include SQL, ODBC, dBase, and Oracle, but the invention herein is not so limited, and the  
20 adoption algorithm may be adapted to include any generic database. Each generic database for  
21 adoption may require a different conversion algorithm.

1       **[0046]** In the preferred embodiment, the knowledge acquisition and retrieval system GUI  
2       provides an interface to allow selection of data export, data import, and data adoption.

3       **[0047]** Referring again to FIG. 6, there is shown the execution module 98 that receives or  
4       extracts data from the knowledge acquisition and retrieval system 10. Referring now to FIG. 7,  
5       the execution module 10 extracts physical and conceptual data information with corresponding  
6       reciprocal associations, to form new memory associations. The execution module 98 typically  
7       extracts only a data subset from the knowledge acquisition and retrieval system 10 for the  
8       specific purpose of deriving relationships corresponding to executable functions such as walking,  
9       jumping, throwing, catching, etc. The execution module 98 may extract information directly  
10      from the storage/association module 14 (i.e., physical and conceptual memory directly), or the  
11      execution module 98 may extract data indirectly through the retrieval module 16 and its retrieval  
12      algorithms. The execution module 98 therefore comprises an interface to extract data subsets  
13      from the physical and conceptual memory segments, a dual memory configuration to store the  
14      extracted data and maintain the reciprocal associations, an association or learning algorithm to  
15      further associate the extracted concepts and relate them to an activity, and an output interface to  
16      output the activity data to the desired output device or sensor.

17      **[0048]** What has thus been described is a knowledge acquisition and retrieval apparatus and  
18      method that emulate the human brain and comprise at least one first memory segment, and a  
19      distinct second memory segment, wherein elements of the at least one first memory segment are  
20      reciprocally associated to elements of the second memory segment, and vice-versa. The at least  
21      one first memory segment comprises categorized data from the physical world, known as

1 representational data, while the second memory segment contains abstract or conceptual data,  
2 otherwise known as consciousness data. Physical data comprises auditory data, language data,  
3 visual data, motion data, and sensory data, and each element of the at least one first memory  
4 segment is identified as auditory data, language data, visual data, motion data, or sensory data.  
5 By reciprocally associating the physical (representational) and conceptual (consciousness) data, a  
6 hierarchical structure is created that allows information retrieval by traversing the reciprocal  
7 associations. Varying retrieval algorithms traverse the hierarchical structure differently to  
8 generate specified system outputs. Retrieval algorithms are implemented to represent human  
9 information retrieval functions commonly known as reduction, imaging, deduction, recognition,  
10 recall, categorization, and reasoning.

11 **[0049]** Although the present invention has been described relative to a specific embodiment  
12 thereof, it is not so limited. Obviously many modifications and variations of the present  
13 invention may become apparent in light of the above teachings. It will be understood that  
14 although the systems have been described with reference to functional blocks, the systems  
15 described herein can be computer programs, such as C language or Java language programs, and  
16 that the blocks depicted herein are merely representative of the procedures and functions that can  
17 be performed by the program. It will further be understood that the systems can be dedicated  
18 hardware devices, or combinations of hardware and software. For example, although the  
19 examples provided indicated three reciprocal database associations for each physical-conceptual  
20 input pairing, multiple-valued pointers may be implemented to effectuate the three relationships  
21 using fewer than three database entries. A database structure is not required, and the system may

1 be built upon different memory segments. Additionally, the physical memory segment may  
2 comprise a single memory device with multiple partitions, or multiple memory devices, or  
3 combinations thereof. The conceptual memory segment may be similarly structured. Although  
4 the system provided for auditory, visual, language, motion, and sensor inputs and outputs, only  
5 one or a subset of such input/output devices may be utilized. Similarly, the input and output  
6 interfaces for the different input or output modes may be shared, separate, and may require  
7 multiple interfaces for a single input or output mode. Although the system was structure as  
8 having input, storage/association, retrieval, and output modules, the modules are not required to  
9 be structured as such, and functionality may be incorporated otherwise. The preferred  
10 embodiment presented seven different retrieval algorithms, but the invention may be practiced  
11 with fewer than seven retrieval algorithms.

12 **[0050]** Many additional changes in the details, materials, steps and arrangement of parts, herein  
13 described and illustrated to explain the nature of the invention, may be made by those skilled in  
14 the art within the principle and scope of the invention. Accordingly, it will be understood that  
15 the invention is not to be limited to the embodiments disclosed herein and may be practiced  
16 otherwise than specifically described, but is to be understood from the following claims, which  
17 are to be interpreted as broadly as allowed under the law.